Horton

Formaldehyde as a Practical Disinfectant for Instruments.*

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In 1868 Von Hoffmann generated from wood alcohol a gas to which was given the name formaldehyde. A 38 to 40 per cent. solution of this gas in water constitutes commercial Formalin. The substance also occurs as a solid in the polymerized form—Paraform.

Within the past five years these preparations have been attracting no little attention in the field of disinfection. To be sure, there has been a marked discrepancy in the results obtained by various workers; some crediting formaldehyde with little, if any, disinfecting power, while others enthusiastically hail it as the ideal germicide. Under these circumstances one is prone to ask, To what extent can we rely upon this substance to destroy undesirable bacteria? Beyond any question, formaldehyde is a good surface disinfectant, as shown by the work of Roux and Trillat (1), Vaillard and Lémoine (2), Bosc (3), Pfuhl (4), Aronson (5), Harrington (6), and many others.

There can be no doubt, from the evidence offered from time to time, that the mouth is often the source of general systemic infection, and, accordingly, there is every reason why the dental surgeon should be as aseptic with the articles he employs as is the general surgeon. Certain infective bacteria, the pyogenic organisms, for instance, are frequently present; while at times, in the sputum and secretions of the mouth are to be found the organisms of diphtheria, pneumonia, tuberculosis, and even syphilis (whatever that may be). Starck (7) reports the presence of the tubercle bacillus in carious teeth. An instrument

* This work was undertaken at the request of Dr. Edward C. Kirk, dean of the Department of Dentistry, University of Pennsylvania. I wish to express my thanks to Dr. Kirk, who furnished the apparatus for the experiments, and through whose kindness I was able to obtain material from the clinics.

once dipped in this undesirable but too frequently present material in the mouth of one patient offers a menace to the health of the next occupant of the chair, since bacteria are no respecters of persons or places.

Realizing that the present methods of disinfection practiced by dentists are in many cases insufficient in themselves, or are improperly carried out by the operators, there has been a desire for a method combining efficiency with such simplicity of manipulation as to leave no excuse for the use of infected instruments by even the careless worker.

Hot water properly used is doubtless satisfactory as a disinfecting agent, but too frequently care is not taken to have the water hot enough and the period of contact with the instrument long enough; and, moreover, the usefulness of edged tools is seriously impaired by exposure to the temperature of boiling water.

With chemical solutions there is too great tendency to merely dip the instrument into the liquid and then wipe it dry. This instantaneous process may be of value in mechanically removing some of the foreign matter, but as a process of disinfection it is not always a success.

G. de Schweinitz (8) recommends immersion of ophthalmic instruments for 20 minutes in 98 to 99$\frac{9}{10}$ per cent. alcohol, and then rinsing in sterile water; but Randolph (9) in testing this method found a growth in 5 out of 100 tubes inoculated from 75 instruments and 25 nails. In a second test Randolph inoculated the instruments with pus-producing organisms, and found the alcohol sterilized but 14 per cent. of them.

The four ways in which formaldehyde is used as a disinfectant are as follows: 1, Formalin; 2, the vapors arising from spontaneous evaporation of Formalin; 3, generation of the gas from methyl alcohol by incomplete combustion; 4, generation of the gas from Paraform by heat.

Eschelman (10) says, "I have been using a 2 per cent. solution [of Formalin] for the last three months and like it very much. It does not blacken or corrode them" [dental instruments].

E. A. de Schweinitz (11), testing the disinfection of ophthalmic instruments by the first method, found an exposure of 35 minutes necessary in a 1 : 2000 solution, or 10 minutes in a 1 : 1000 strength. In the second method, with the vapors from a shallow dish of Formalin in a closed copper drying oven, he found disinfection complete in 30 minutes, provided the Formalin had been placed in the oven some hours previously. But he says infected instruments wiped with cotton were not disinfected by a 10 minute exposure in this atmosphere, unless rinsed in water before wiping, and then exposed for 10 minutes.

Bierring (12) used formaldehyde gas generated from wood alcohol by a No. 1 Hollister generator, the chimney of which fitted in an opening into a metal hot-air sterilizer of 2752 cubic inches capacity. After an exposure of 10 minutes in this way he obtained a growth from all instruments, while after 30 minutes' exposure growths resulted only from spore-forming organisms, or from organisms protected by four thicknesses of an apron. He concludes that as a sterilizing agent for surgical purposes an alcohol gas generator may be used for instruments only, with an exposure of at least 30 minutes, when confined to a space not exceeding two and one-half cubic feet.

Reik and Watson (13) report adversely on the disinfection of instruments with vapor of Formalin under two and one-half hours' exposure, but with formaldehyde generated from Paraform by a satisfactory lamp* they found instruments could be sterilized in a small chamber in from 10 to 15 minutes, using respectively 5 and 3 grains of Paraform to the cubic foot of space.

For various reasons, the fourth method stated above seems the desirable one, and it was to determine the practical value of this method of disinfection for dental instruments that our work was undertaken. We employed the gas generated by heating over an alcohol lamp a pastil which contained 5 grains of Paraform. The lamp was placed in a tin box of nearly one cubic foot capacity. This box was tight when closed, as shown by the fact that only a very slight odor was discernible near the closed box, while a strong odor was present when the door was opened.

Among the instruments employed in the tests were various chisels, excavators, and burs. These were boiled, shown by cultural methods to be sterile, then either dipped into bouillon cultures or infected from selected cases found in the operative clinic of the Department of Dentistry, University of Pennsylvania. After infection each instrument was placed in a sterile tube and kept at incubator temperature (37.5° C.) for three hours, as Pfuhl (14) says dried cultures are more difficult to kill than moist ones, with which statement Harrington (6) and de Schweinitz (15) agree. In a single test with moist instruments we found sterilization complete. After the infection and subsequent drying the tubes containing the infected instruments were separated into two lots, one to be subjected to the method of disinfection and the others to be kept as controls, by which would be shown that no step other than the action of formaldehyde destroyed the vitality of the germs. The cotton plugs were removed from the tubes contain-

*Drs. Reik and Watson, in their report published in the Bulletin of the Johns Hopkins Hospital, Dec., 1897, made the following statement: "After using two ordinary alcohol lamps in our possession we abandoned them for the Schering Formalin Lamp, which we found more efficacious, generating far more gas with the amount of oxygen at our disposal, and being much more economical in its use of alcohol." S. & G.

ing the instruments to be disinfected, the tubes placed on wire racks* in the disinfecting chamber, the alcohol lamp lighted and placed in the chamber, when a pastil was dropped into the cup above the flame and the door of the chamber closed.

After exactly 10 or 15 minutes, according to the experiment, the door was opened and the instruments quickly removed, in order to make the time accurate. Each instrument (controls likewise) was placed in a considerable amount of sterile bouillon and these cultures, together with the subcultures made from them, observed for at least one week, as recommended by the Committee on Disinfection, American Public Health Association (16). The disinfecting chamber was opened and freely aired after each experiment. **No injury to any of the instruments from the effects of the gas was observed,** which agrees with the statements of Eschelman (10), de Schweinitz (11), Burnett (17), and Reik 18). In all experiments a free growth developed from the controls. **After an exposure of 15 minutes the only growth obtained (g^2) was a pure culture of an organism not found in the control (g^1). It evidently was an accidental air infection, which, moreover, was readily killed by a subsequent similar exposure. After an exposure of 10 minutes growths were found only in the more resistant germs,—viz., staphylococcus pyogenes aureus and bacillus anthracis. Each of these resisted disinfection twice out of six times in an exposure of 10 minutes.** The disinfection of instruments purposely infected in the clinics from the cases of caries, pyorrhea, and gingivitis was satisfactorily accomplished in every case.

In experiment 4 a comparative test was made to see if enough formaldehyde remained on the instruments to act as an antiseptic in even the quantity of bouillon used, and thus prevent development there. This was done by making two groups of the instruments. The details of the test were identical for the two groups, except that the instruments of the second group were washed two or three minutes in a 1 per cent. ammonia solution just after the application of the formaldehyde,—*i.e.*, just previous to the inoculation of the bouillon with them. The controls (4b) which were washed in the ammonia exhibited just as vigorous a growth as the controls (4a) not subjected to the ammonia treatment, showing that the ammonia had no deleterious effect.

We conclude that infected dental instruments can be disinfected without injury in a closed space of less than one cubic foot, by an exposure of 15 minutes to the formaldehyde gas generated from a pastil

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* In part of the experiments the instruments were taken from the tubes and laid directly on the racks, but no difference in result was noticed, the gas, as one would expect, freely entering the open tube.

containing 5 grains of Paraform, by heating the pastil over a proper alcohol lamp.*

The results of our experiments are appended in tabulated form. Growth = +. No growth = 0.

EXPERIMENT 1. Time of exposure, 15 minutes.

Infection.	Designation.	Result.
Aureus culture	a^1 control.	++ in 1 day.
" "	a^2	0 in 10 days.
" "	a^3	0 " " "
Diphtheria culture	b^1 control.	++ in 1 day.
" "	b^2	0 in 10 days.
" "	b^3	0 " " "
Streptococcus culture	c^1 control.	++ in 1 day.
" "	c^2	0 in 10 days.
" "	c^3	0 " " "
Osteitis from tooth-infection following extraction	d^1 control.	++ in 1 day.
" " "	d^2	0 in 10 days.
Pulp-canal, putrefactive contents, upper bicuspid	e^1 control.	++ in 1 day.
" " "	e^2	0 in 10 days.
Anthrax culture	f^1 control.	++ in 1 day.
" "	f^2	0 in 10 days.
" "	f^3	0 " " "
Pyorrhœa alveolaris from pus pocket chlorotic female	g^1 control	++ in 1 day.
" " "	g^2	+ in 1 day.†

EXPERIMENT 2. Exposure, 10 minutes. All controls gave free growth in one day.

Infection.	Designation.	Result.
Pulp case	a^1 control.	++ in 7 days.
" "	a^2	0 "
Caries	b^1 control.	++ "
"	b^2	0 "
Local gingivitis pyorrhea	c^1 control.	++ "
" " "	c^2	0 "
" " "	c^3	0 "

*The cabinet used in these experiments was SCHERING'S FORMALIN STERILIZER—vide illustration on page 8. It is constructed of tin, and japanned on the outside; it is 18 inches wide, 11½ inches high, and 8 inches deep; hence its contents of air is a little less than 1 cubic foot. Schering's 5 grain Paraform Pastils have been vaporized in Schering's Formalin Lamp which is specially constructed for the vaporization of Formalin pastils and it is the only method which is absolutely safe, reliable, convenient, cleanly, simple, and cheap. (Note by Schering & Glatz).

†This growth was a pure culture of an organism not found in g^1. It was doubtless an air infection, and was killed by a second similar exposure.

Infection.	Designation.	Result.
Typhoid culture	d^1 control.	++ in 7 days.
" "	d^2	0 "
" "	d^3	0 "
Diphtheria "	e^1 control.	++ "
" "	e^2	0 "
" "	e^3	0 "
Aureus "	f^1 control.	++ "
" "	f^2	0 "
" "	f^3	+ in 2 days.
Anthrax "	g^1 control.	++ in 7 days.
" "	g^2	+ in 1 day.
" "	g^3	+ "
Streptococcus culture	h^1 control.	++ in 7 days.
" "	h^2	0 "
" "	h^3	0 "

EXPERIMENT 3. Exposure, 10 minutes. Controls gave free growth in one day.

Infection.	Designation.	Result.
Typhoid culture	i^1 control.	++ in 7 days.
" "	i^2	0 "
" "	i^3	0 "
Diphtheria "	j^1 control.	++ "
" "	j^2	0 "
" "	j^3	0 "
Aureus "	k^1 control.	++ "
" "	k^2	+ in 2 days.
" "	k^3	0 in 7 days.
Anthrax "	l^1 control.	++ "
" "	l^2	0 "
" "	l^3	0 "
Streptococcus culture	m^1 control.	++ "
" "	m^2	0 "
" "	m^3	0 "

EXPERIMENT 4. Exposure, 10 minutes. Controls gave free growth in one day.

a, Instruments not washed in 1 per cent. ammonia.

Infection.	Designation.	Result.
Aureus culture	a^1 control.	++ in 7 days.
" "	a^2	0 "
Anthrax "	b^1 control.	++ "
" "	b^2	0 "
Typhoid "	c^1 control.	++ "
" "	c^2	0 "
Diphtheria"	d^1 control.	++ "
" "	d^2	0 "

b, *All* instruments washed in 1 per cent. ammonia solution just previous to making cultures from them.

Infection (same as 4 *a*).	Designation.	Result.
Aureus culture.....	a^3 control.	++ in 7 days.
" "	a^4	0 "
Anthrax "	b^3 control.	++ "
" "	b^4	0 "
Typhoid "	c^3 control.	++ "
" "	c^4	0 "
Diphtheria"	d^3 control.	++ "
" "	d^4	0 "

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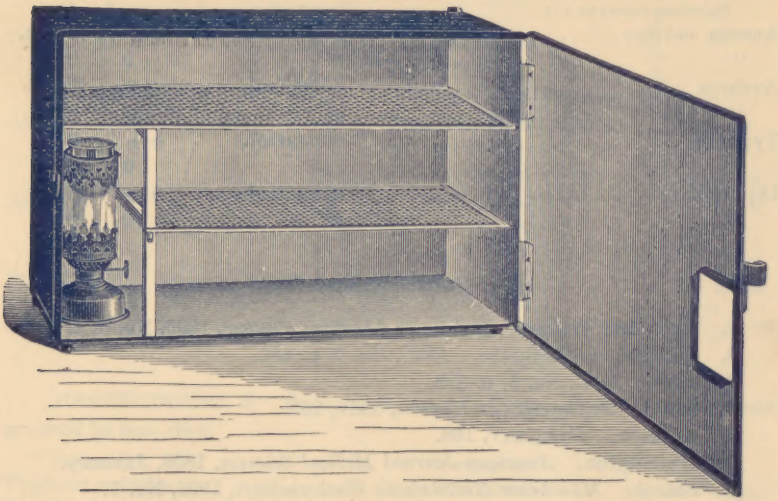

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